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The origin of dwarf plants as shown in a sport of Hibiscus oculiroseus

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(WITH PLATES 26 AND 27)

The publication in 1901–1903 of Die Mutationstheorie aroused a new interest in the well-known sports or spontaneous variations of earlier writers. While Darwin had recognized the occurrence of such variations he did not consider that they were the sole means or even the most frequent means by which species originated. De Vries sought to separate mutability as a type of sporadic variability from fluctuating variability, to define quite different laws for the two, and to ascribe to the former the only power to give rise to forms of specific rank.

Since 1901 much further evidence has accumulated regarding the appearance, the behavior, and the heredity of so-called mutations. It is fully established that marked variations do appear and that these are often hereditary. This phase of the general doctrine of variation is fully established. Of the various practical and theoretical considerations presented by these cases none are more fundamental than those relating to the expression and the heredity of "newly born" characteristics.

The general conception of mutation and the categories of behavior that indicate the process were combined by De Vries with the doctrine that plant characters are to be considered as so exactly represented by definite hereditary units that they can be properly called "unit characters." De Vries especially em-

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phasizes this view in the preface of the English translation of Die Mutationstheorie (1909).

It has also been shown that numerous cases of hybridization result in an increased variability in the F_2 generation over that of the parents, in the production of intermediate forms, and in unexpected ratios. The Mendelian factorial hypothesis, which attempts to explain such phenomena, assumes that the difficulties of analysis in terms of unit characters indicate that characters are themselves the results of the combined action or interaction of hereditary units called factors to which various values can be attributed as seems necessary. There are some striking cases of reversion resulting from crosses that seem to support this view; as, for example, the production in sweet peas of the reversionary purple bicolor known as "Purple Invincible" from crosses between certain white flowering strains of "Emily Henderson" (Bateson, 1913, Chap. V). The developments of the Mendelian theory have led, however, to various and conflicting conceptions regarding the nature of the hereditary units and of the fundamental processes of mutation or discontinuous variation.

De Vries on the one hand considers that mutability is due to lability of hereditary physiological units; these change from stable to labile, from active to inactive (or latent) or even to a semilatent condition, giving irregularities of expression both in inbred and crossbred lines of progeny. Only in the rare cases of progressive mutation are new characters added and in none of the mutations is complete loss of hereditary qualities essential. The units of De Vries assume different degrees of activity; they are not uniform and consistent units in their influence.

In marked contrast to this view is the conception of Bateson that all variation is due to the presence or absence of "unit factors", that all true mutation is due to loss of factors, and that cases of discontinuous variation resulting from crosses are reversions which are due to recombination of factors. This view minimizes the occurrence of latency, ignores lability and insists on a rather rigid unity of assumed hereditary units, not in any sense comparparable with the appearance of the visible characters of plants.

These two very different interpretations indicate clearly the

difficulties that arise in the attempts to analyze the facts of heredity and variation in terms of units and raise anew the questions as to the validity of the conceptions regarding mutation.

It is the purpose of this paper to present the facts as thus far determined regarding the origin and the behavior of a marked variation in *Hibiscus oculiroseus* and to point out some considerations suggested by such cases.

THE DWARF FORM OF HIBISCUS OCULIROSEUS

The two plants shown in PLATE 26 are typical for the appearance of dwarf and robust plants of *H. oculiroseus* at the end of the first year of growth as handled in my cultures. Both plants were from seed planted in January, 1914. The seedlings were grown in pots in a greenhouse until May, when they were planted in adjoining beds in the experimental garden. The photograph was taken September 13, 1914. A glance at the plate will show the marked differences that exist between the two types. The dwarf plant is shorter, but is more branched with large well-developed lateral branches arising close to the base; the internodes are shorter, making the leaves more crowded; the leaves are smaller and many of them are somewhat irregular or asymmetrical in outline and many of them are crinkled. Few of the dwarf plants have thus far come into flower, but those that have showed flowers nearly if not fully as large as the robust types.

From the data regarding the ancestry of the dwarf plants, it appears that a plant of *Hibiscus oculiroseus* was obtained by the New York Botanical Garden from the firm of Pitcher and Manda in the year 1896. This firm obtained their original stock of this plant from Mr. W. F. Bassett of Hammonton, New Jersey, who introduced the plant (Britton, 1903) into the trade some years before. Bassett obtained the first plant of this type about the year 1880 from a colony of wild plants growing near Absecen, New Jersey. The plant was propagated by seed, and introduced into the trade. It was commonly called the "Crimson Eye."

Britton (1903) points out that this type differs from *H. Moscheutos* in several characters. *H. Moscheutos* in its most abundant form, at least in the vicinity of New York City, has flowers of a

rose color, lighter along the veins and becoming nearly pure white for about 1 cm. at the base of the corolla lobes. *Hibiscus oculiroseus* has a rose red or Tyrian rose eye about 2 cm. in radius, beyond which the petal is a sea-foam yellow. The flower pods are ovoid with a long tapering point, the calyx segments are triangular-lanceolate and nearly twice as long as broad. *Hibiscus Moscheutos* has a nearly globular bluntly pointed pod. On this account he gives the type specific rank under the name *H. oculiroseus*.

CULTURES OF H. OCULIROSEUS AT THE NEW YORK BOTANICAL GARDEN

Open-fed seed was collected from the plant obtained from Pitcher and Manda and planted for the purpose of increasing the stock of the species. The progeny (Nash, 1909) was composed in part of plants conforming to *H. oculiroseus* and in part of plants whose flowers suggested that the plants were hybrids between *H. oculiroseus* and the rose-flowered type of *H. Moscheutos*, an assumption which the writer has since proved to be true by controlled crosses.

At the time the writer began his investigations with *Hibiscus* (1911) there were seven plants of the *H. oculiroseus* characters growing in the Garden, all derived from the one parent plant. All of these were vigorous plants about five feet tall. Five of these plants have been used as parents and will be referred to as *O* No. 1, *O* No. 2, etc.

One of these plants (*O* No. 1) produces each year a considerable number of leaves, somewhat crinkled and irregular, and the uppermost internodes of the branches are somewhat shortened. One would be inclined to attribute this to a fluctuating variation due perhaps to local soil conditions. The other four plants show no trace of any of the dwarf characteristics.

PLANTS OF THE FIRST PEDIGREED GENERATION

In 1912, fifteen plants (Series I) were grown from open-fed seed collected from the plant *O* No. 1. Fourteen of these were robust and vigorous in growth, but three of them had some leaves

irregular in shape and also exhibited a shortening of internodes at the tips of stems quite identical to that of the parent plant and were in general intermediates between the robust type and the extreme dwarf type. One plant was of the dwarf type quite identical with the one above described. Ten of the plants, including the dwarf and one of the intermediates, were grown in 1913, when all bloomed. The dwarf plant (No. 1 of Series I) continued small and much branched with many crumpled leaves. Two capsules of selfed seed were obtained from this plant and one capsule was obtained from a sister plant (No. 5 of Series I) of the robust type.

As to flower coloration and pod character, nine of the ten plants were typical *H. oculiroseus*. One plant had flowers with faint pink coloration outside the eye in the blade of the corolla, although at a short distance or upon casual survey the flowers appeared to be typical *H. oculiroseus*. There was outside of this one plant no indication but what the seed obtained was strictly selfed, and even in this one case the flowers borne were not such as have been obtained in the F_1 hybrids between the parent plant and the only other type of *Hibiscus* growing in the vicinity of the seed parent.

The winter of 1913–14 was unusually severe on the *Hibiscus* plants growing in the experimental plots, killing about 1,500 plants of various cultures, including the dwarf plant (No. 1) and the robust plant (No. 5) of Series I, from which selfed seed had been obtained.

In addition to the plants of Series I, there were also grown during the summer of 1913 forty-five plants (Series VI) derived from selfed seed obtained during the summer of 1912 from the same parent plant (*O* No. 1). All of these were dwarf plants. Four produced flowers that were typical *H. oculiroseus*. No seed ripened and all the plants died during the winter of 1913–14. All the plants of this series were dwarfs, while of the fifteen plants of another series (Series I) from a pod of the same parent only one dwarf appeared as already noted.

The dwarf character of these plants was most conspicuous in comparison with the selfed progenies of four other plants of *Hibiscus oculiroseus* (sister plants of *O* No. 1) grown during the

summer of 1913 from seed of 1912. The data for these can be briefly summarized as follows: from plant *O* No. 2, nine plants were grown, of which four bloomed; from plant *O* No. 3, forty plants, of which ten bloomed; and from *O* No. 5, twenty-seven plants, of which none came into flower. All of the plants in these four series, 103 in number, were typical for the robust type with no trace of any of the dwarf characteristics. The twenty-four plants that bloomed were true to the *H. oculiroseus* type of flower. None of the plants matured seed and every one was killed during the winter of 1913-14.

PLANTS OF THE SECOND GENERATION

In the summer of 1914 three series of plants were grown, constituting a second generation in descent from the parent *O* No. 1. These may now be described.

Series VII. The parent of this series was a dwarf plant (No. 1 of Series I). Thirty-five plants were grown from seed of a single pod. Twenty-seven were uniformly of the dwarf type; one was a typical robust plant and seven were intermediates showing in slight degree the characteristics of the dwarf type. Six plants bloomed; one had eyed flowers with pale pink in the blade (quite similar to No. 8 of Series I), three had the eye somewhat diluted, and on two the eye of the flower was so diluted that the flowers appeared to be nearly pure white. The one plant of robust habit had flowers of a type which suggests that it is a stray plant of hybrid origin.

Series VIII. Of the same parentage as the Series VII. Forty-six plants were grown from selfed seed of a single capsule. Forty-five of these were dwarf quite like the one from this series shown on PLATE 26. One plant was intermediate but was different from other intermediates in possessing a considerable development of lateral branches, the main branch was itself robust and the leaves were only slightly crinkled. The five plants that bloomed were all typical for the *H. oculiroseus* type and were only slightly if any smaller than the flowers of robust plants. The plants of this series are shown in the middle of PLATE 27 with the marker standing in their midst. The plants of Series VII are shown

beyond the label stake in the rear. The intermediate plant in Series VIII just mentioned is shown at point *a*. To the right in the foreground are hybrids between *O* No. 2 and a plant of *Hibiscus Moscheutos*, and to the left are hybrids between two types of *H. Moscheutos*, all of the same age as the dwarf plants.

Series IX. The thirty-four plants of this series were grown from the selfed seed of one capsule of plant No. 5 of Series I. The parent was a robust plant. Thirty-three of the plants were of the robust type quite uniformly like the one of this series shown on PLATE 26. One plant was classed as an intermediate; it was smaller than the others, its leaves were somewhat crinkled, but it was not branched from the base. Twelve plants produced flowers; ten of these were typical *H. oculiroseus*, one had flowers with slight pink coloration outside the eye, and on one plant the flowers were quite pink outside the eye, quite like the flowers produced by hybrids between *H. oculiroseus* and the pink-flower type of *H. Moscheutos*.

Nearly all the plants of these three Series (VII, VIII and IX) lived through the winter of 1914–15 and were grown during the summer of 1915 in the same beds as in the previous year. In the second year of growth several main stems, usually three to five, are produced by the single cluster of roots belonging to a plant. As the plants were grown about 30 cm. apart they were much crowded in the second year, which is a condition that does not favor the development of secondary branches and hence the plants were much less bushy than in the first year of growth. Under these conditions there were fewer differences between plants previously classed as intermediate and dwarf.

In 1915 the plants of Series VII ranged from 1.25 m. to 1.6 m. in height with the exception of the plant classed as robust which was 2.08 m. tall but which from the character of its flowers appears to be an accidental hybrid. Series VIII ranged from 1.3 m. to 1.6 m. in height. The dwarf plant shown to the left in PLATE 26 had four main branches and stood 1.45 m. tall and was typical for the average plant; the plant shown at point *a* in PLATE 27, classed as intermediate in 1914, was of nearly the same height and appearance. Series IX, described as robust in 1914, varied

from 1.75 m. to 2 m. in height with the average quite 0.3 m. taller than that of Series VII and VIII.

During 1915 there was also grown from seed a series of twenty-eight plants from selfed seed of plant *O* No. 1, the parent of the Series I and VI. On August 25, these plants varied from 0.4 m. to 0.75 m. tall and nearly all had the dwarf characteristics. The series showed greater variation in general vigor than did the plants of Series VII and VIII in their first year of growth. A series of twenty-three plants derived from selfed seed of one of the robust plants of Series I, grown at the same time were in comparison decidedly robust averaging from 0.8 m. to 1 m. in height and with no crumpled leaves or strongly developed lateral branches. Another series of eleven plants descended from a plant of Series I classed as intermediate was on the whole intermediate between the two series just mentioned.

SUMMARY OF THE CULTURES

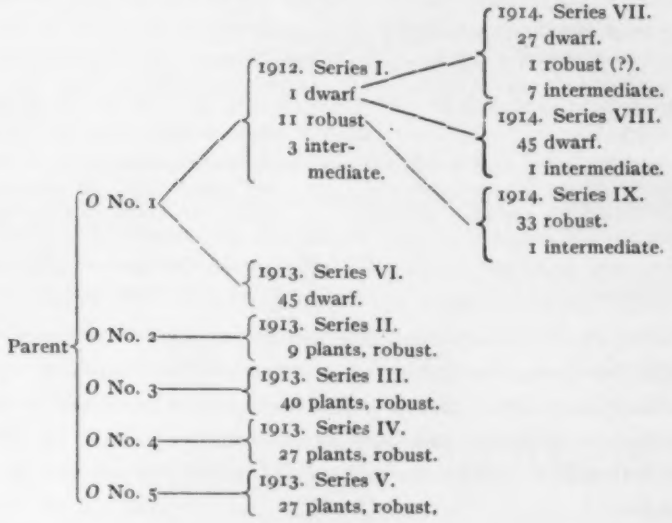
A total of 288 plants have been grown (at least through a single season) from seed obtained from five sister plants of *Hibiscus oculiroseus*. The dwarf type of plant has appeared only among the progeny of a single plant (*O* No. 1); the 103 plants derived from the other four sister plants were without exception of the robust type.

There was much diversity among the progeny of the plant *O* No. 1, and the two series of plants grown in the first generation gave quite different proportions. In Series I, there were eleven robust, three intermediate and one dwarf; in Series VI there were forty-five plants, all of which were dwarf.

The progeny of a single dwarf plant (the only one that has thus far matured seed) was composed of one robust (later appearing to be an accidental hybrid), eight intermediate and seventy-two dwarf plants. While the dwarf type has not bred true the greater number of the progeny are of that type. There is a pronounced tendency to breed true. Robust plants in this line of descent do not always breed true, as the only one tested gave one intermediate plant and thirty-three robust plants.

A condensed schematic presentation of these facts regarding

the progenies of different lines of descent, not including the series started from seed in 1915, is given in the accompanying diagram.



DISCUSSION

The dwarf type of *Hibiscus oculiroseus* constitutes a marked and distinct variation from the usual robust type of the species. It has smaller leaves, many of the leaves are crumpled, the internodes are shorter, and there is an increased development of branches. It is such group-differences as these that constitute the elementary species of De Vries, for, as he states (1901, p. 176): "Elementare Arten unterscheiden sich von ihren nächsten Verwandten mehr oder weniger in allen ihren Merkmalen." All the changes, however, are considered to be a result of a change in the condition of a single pangen.

It is difficult or impossible to describe such a mutation in terms of definite characters that have been gained or lost. The ordinary type of development of the leaves and internodes have been modified mainly in the direction of arrested growth, while the amount of branching has been increased, due chiefly to the development of basal lateral buds that usually remain dormant.

In comparison with the robust type the characteristics of the typical dwarfs are readily recognized, the general effect being

quite adequately shown in the illustrations on PLATES 26 and 27. The characteristics of the two types can be listed as follows:

Robust form	*Dwarf form*
First year of growth, 0.8–1.1 m.	0.4–0.75 m.
Second year of growth, 1.75–2 m.	1.25–1.6 m.
No branching from base of shoots.	Large branches from base.
Internodes about 30 in number.	Internodes about 30 in number, but all proportionally shorter.
Leaves ovate, larger ones lobed, palmately veined, densely white stellate-pubescent beneath, glabrous above; leaves all flat.	Leaves identical except that the largest are smaller than the average of robust type; many leaves crinkled.
Flowers and fruit are typical *H. oculirosens*.	Flowers and fruit identical with those of robust form; apparently no smaller.

While typical plants classed as robust and dwarf were very uniform in the above characteristics, there were a few plants, as noted, described as intermediates or semi-dwarfs, which possessed in some degree of development one or more of the characters of the dwarf form but which in the second year of growth were less distinguishable.

The mutant of *Oenothera Lamarckiana* that most nearly approaches in its characters the dwarf *Hibiscus* is, of course, *Oe. nanella*. The principal characteristics of this plant compared with those of the parent form as given by the description of De Vries may be given as follows:

Oe. Lamarckiana	*Oe. nanella*
Robust: 1.5–1.8 m. tall.	Dwarf: about one-fourth as tall as *O. Lamarckiana*, often blooming when 10–20 cm. tall.
Secondary branches abundant and strong.	Secondary branches lacking or nearly absent.
	Internodes much shorter making leaves and flowers more compact.
Leaves ovate-lanceolate; long petioled, much crumpled surfaces.	Leaves sessile or nearly so; broad at base, often auriculate or heart-shaped; petioles very brittle.
Flowers with petals 3–4 cm. long; buds thin, tapering to a point.	Flowers very nearly as large; buds often laterally twisted.
Fruit and seeds normal.	Fruit and seeds of almost normal size.

The dwarf *Oe. nanella* differs from *Oe. Lamarckiana* in nearly all of its vegetative organs. De Vries maintains, however, that such a mutation is brought about by a change in the activity of

a single hereditary "pangen," but that the visible result depends only partly on the direct results of the changed condition in one pangen. On this point he states (1901, p. 305): "Der äussere, sichtbare Erfolg hängt also nur zum Theil von der Mutation, zum Theil aber auch von den älteren Merkmalen ab. Oder mit anderen Worten, die neue Art kennzeichnet sich in der Regel nicht durch eine enizige neue Eigenschaft, sondern dadurch, dass veile oder alle Organe in bestimmter Weise umgestaltet wurden." This means that in the case of *Oe. nanella* when the *alta* pangen (1913) becomes inactive it affects not only the height of the plant but also produces a transformation of many other characters, such as the nature of the leaves and the branching. De Vries states regarding *Oe. nanella* (1904, p. 532): "The most remarkable feature is the shape of the leaves. They are broader and shorter, and especially at the base they are broadened in such a way as to become apparently sessile. The stalk is very brittle, and any rough treatment may cause the leaves to break off." These remarkable differences in the leaves are brought about, De Vries assumes, by a change in the "*alta* pangen", a pangen concerned with the height of the plant. Such a view is, it would appear, *directly opposed to a conception of independence between heredity units*. We get in such cases the clearest possible conception of the application of De Vries's idea of a heredity unit ("pangen") as an element of the germ-plasm which affects and determines the character of a plant as a whole, constitutionally, and in all or many of its characters. Such a view is quite different from the units of Weismann, which were assumed to be individual in effect and sufficiently numerous to correspond directly to every detailed feature of expression.

The original Mendelian doctrines of unit characters assumed qualitative germ cell units, independent in action, and each responsible for the expression of a character. Color and wrinkledness of peas (qualities of the cotyledons) were considered as separable hereditary units quite independent of any preformation of the cotyledons themselves. Mendelian theories have been concerned with the phase of development and heredity which involves qualities, and though evading the difficulties of assumed spacial relationship in preformation, they assume that the qualitative

values of the "factors" are predetermined. It is an important fact established especially by Mendelian studies that qualities of organs may appear and disappear independently of the organ and to certain degrees independently of each other. This suggests that the older conceptions of the preformation of organs as such do not hold and that a hereditary unit for an organ with all its characteristics does not exist. This is very clearly seen in the numerous studies of inheritance and variation of color in which organs like petals, leaves, and stems of plants, eyes of insects, etc., re nain quite the same except for color. Such facts emphasize on the one hand the wide possibilities of latency as most excellently developed by De Vries, and on the other the most evident fact that qualities which appear to be localized in organs are more often general qualities of the entire organism, the development of which is a matter of intercellular and inter-tissue relationships.

The arguments of De Vries consistently seek to establish the doctrine of the fewness of the pangens. On this basis dwarfness is assumed to be the same in all the different cases in which it appears throughout the plant kingdom.

No consistent uniformity, however, exists among the dwarf types derived in different species or even in the same species. Some types of dwarf garden peas appear to differ from tall varieties chiefly in the character of the internodes. In the "brachytic" varieties of cotton (Cook, 1915) the shortened internodes a id modified leaves and bracts are usuall confined to the fruiting branches. Numerous types of dwarf and semi-dwarf types exist in many species, a notable instance of which has been recently described by Bartlett (1915), who found that two dwarf types arose in a single pedigreed generation of *Oenothera Reynoldsii*. One of these, *semialta*, is about half as tall as f. *typica* and has a very dense and showy inflorescence, in which the fruits and flowers are very little smaller than in the parent form. The leaves, however, are decidedly reduced. As described by Bartlett (1915, p. 130) the sister dwarf "*debilis* is more variable in size than mut. *semialta*, but averages about half as high as the latter. Its fruits and flowers are somewhat reduced, but by no means proportionally to the plant. The leaves, on the contrary, are much more reduced than those of mut. *semialta*".

Bartlett has not discussed these in terms of characters that have been gained, lost, or modified, but does point out that the appearance of these two dwarf forms as sister mutants in the rather large number of individuals "bears a certain degree of resemblance to Mendelian segregation." The case is especially interesting in affording a record of the simultaneous origin of hereditary variations from a single parentage giving dwarf forms of markedly different characteristics.

Furthermore, the facts of variation resulting from hybridization involving dwarf forms indicate a diversity of behavior quite in line with the above-mentioned facts. Mendel considered that the dwarf garden pea differed from the tall in a single character pair and that he obtained neither intermediates nor a greater range of variation in the F_2 generation. Darbishire (1911) considers that this is the case and that the dwarf garden pea differs from the tall variety only in respect to two types of internodes, long and short. Punnett (1911, p. 35) applying the conception of presence and absence very generally to peas states "all peas are dwarf, the tall pea is a dwarf plus a unit factor." This generalization is not borne out by the data. Lock (1904) in progeny of crosses between a tall and a semi-dwarf ("Satisfaction" and native No. 2) found in the F_2 great variation in habit ranging from very robust to very feeble dwarf. Although he considers that there must be some sort of Mendelian segregation if the internodes are solely considered, he admits that "this cross seems to afford an example of remarkable intensification of both the allelomorphic characters of the same pair, namely tallness and dwarfness, the former in the F_1 and both in the F_2 and later generations" (p. 414). Keeble and Pellew (1910) in crossing two well-known staple semi-dwarfs varieties of the garden pea obtained in the F_2 a wide variation, giving both dwarf and tall as well as intermediates. They conclude that length of internode and width of stem are both involved and in their interpretation dwarfs lack both factors, semi-dwarfs lack one and talls possess both. Height in sweet peas is also of complex character, as breeding studies of dwarf, semi-dwarf and tall varieties have shown. Crosses with bush and "Cupid" give an F_1 that is tall and an F_2 with variation involving plants that include tall, bush and

two types of "Cupid". Bateson attempts to explain this case as he does all cases of increased variation in terms of presence or absence of factors, giving *different interactions in different combinations*. The point is clear that greater variability does develop and that not only is height of sweet peas evidently a compound character, but that the assumed factors take on different values. For example, the factor T ("tallness") when combined with P (erect: branching) gives the bush variety. The two sets of allelomorphs assumed in this case are not independent units in expression. It may be emphasized that the original rigid unit-factor hypothesis is being given up in favor of the admission, as we see in this case, of a marked modifiability of the effect of the assumed factors. The integrity of the assumed units in these cases can only be maintained by assuming a permanence in them, which is entirely at variance with the visible results which they are assumed to produce.

The behavior of the dwarf characteristics of *Oenothera nanella* in hybridization is of special interest in this connection. The group of characters appearing in *Oe. nanella* go together in crosses with *Oe. Lamarckiana*, not as a unit giving alternative expression but in the splitting that develops in the F_1 generation giving the parent forms as twin hybrids. De Vries assumes (1913) that the *alta* pangen is inactive in *Oe. nanella* and labile in *Oe. Lamarckiana*. In this case inactive $\times$ labile gives both inactive and labile.

When *Oe. rubrinervis* is crossed with *Oe. nanella* splitting also occurs in the F_1 giving *Oe. Lamarckiana* and a new type called *Oe. subrobusta*. The *alta* pangen in *Oe. rubrinervis* is assumed to be active, so in this case active $\times$ inactive = labile and inactive + active. The *Oe. subrobusta* form splits in the next generation, giving dwarf forms which, however, are evidently not *Oe. nanella*. *None of the types derived are like either of the two parent forms.*

Again when *Oe. muricata* is crossed with *Oe. nanella* the F_1 is of two new types called *Oe. laeta* and *Oe. velutina*. *Oe. velutina* splits up in the F_2 giving a dwarf *Oe. murinella* that is not like *Oe. nanella*. None of the types are like the parent forms. The assumed condition of the *Oe. alta* pangen in this case is active $\times$ inactive = labile, active and inactive.

The appearance of twin hybrids not like the parents and of sec-

ond generation dwarfs not like *Oe. nanella* is also the rule in crosses between *Oe. nanella* and *Oe. Hookeri*, *Oe. Cockerelli*, *Oe. cruciata* and also *Oe. biennis* when the latter is the seed parent.

When *Oe. nanella* is fertilized by pollen from *Oe. biennis* the F_1 is composed largely of dwarf plants. In the earlier crosses De Vries reports a few tall plants and many dwarfs (1913, p. 241) but from a cross in 1907 he obtained only dwarfs which, however, he classed in two types, *Oe. semialta* and *Oe. debilis*, each of which was different from the *Oe. nanella* parent. In this case the condition of the *alta* pangen in the hybrids is assumed to be inactive × labile, which is the same condition assumed for *Oe. nanella* × *Oe. Lamarckiana*.

De Vries finds in such behavior evidence of the production of new species in groups by hybridization. He assumes that a few pangens are involved and that those exist in few conditions. The integrity of such units can only be assumed by calling in such all-sufficient properties as lability and inactivity which admit of very sporadic behavior.

It is generally assumed that a new elementary species arises suddenly without transitional forms. This is not the case with the dwarf type of *Hibiscus* here described. The plant *O* No. 1 from which all dwarf plants thus far obtained have arisen, possessed a few of the characteristics of the dwarf. The next generation gave dwarf, intermediates and robust plants in quite irregular numbers in the two series grown. Bartlett (1915) describes two dwarf types arising in a progeny of *Oe. Reynoldsii*, one of which (*semialta*) is intermediate in general stature and has leaves less reduced than in the extreme dwarf form (*debilis*). Variations such as these are not like ordinary fluctuations in giving a frequency distribution agreeing with Quetelet's law and they do not conform to the Mendelian ratios of segregation, although as Bartlett points out, there is much in the behavior that suggests the segregation assumed by Mendelian interpretation. *They are irregular and sporadic variations* involving different degrees and intensity of change. The most marked of these involve changes affecting the character of several organs.

Further evidence regarding irregular expression of characters is

seen in the well-known cases cited by De Vries of non-isolable races, eversporting varieties, and inconstant species, indicative of irregular and sporadic inheritance and expression of ever present tendencies which in these cases rigid selection fails to isolate.

That there are cases of variation that are cumulative is evident. De Vries especially has given data on two such cases. In a race of *Chrysanthemum segetum*, having an average of twenty-one ray florets in the terminal inflorescence in a crop of 1,500 plants one plant was found with four lateral flower heads with twenty-two ray florets. Seed from this plant gave a progeny of 423 plants one of which had a terminal inflorescence of thirty-four rays. Seed from this plant gave a mixed progeny with one plant having sixty-six ligulate florets, three of which were among the tubular disk flowers. Seed from this plant gave progeny with florets ranging from thirty-three to one hundred and one with a few completely double flowers.

In respect to these results De Vries says (1901, p. 526): "Es wird sich jedem Leser die Frage aufdrängen: ist dieser Uebergang ein allmählicher oder ein stossweiser gewesen? Mir scheint das letztere der Fall zu sein, aber es hängt dabei viel ab von der Bedeutung, welche man den Wörtern giebt. Jedenfalls geschah die Umwandlung nicht im Laufe der Jahrhunderte, wie es die Selectionstheorie anzunehmen pflegt, nicht einmal brauchte es dazu Jahrzehnte. Drei Jahre genügten, und solches in einer Cultur von nur wenigen Quadratmetern Umfang."

De Vries considers that this result is due to the reappearance of a latent character. It is not clear what the latent character is in this case. The species already possessed ray flowers in the outer circle of flowers. The development of a so-called double-flowered race consisted of a change of tubular flowers to ray flowers. Furthermore, as wholly double flowered plants are sterile, the double flowered plants are obtained continually by planting seed from plants not fully double flowered.

A similar case is seen in the development of *Linaria vulgaris peloria*. Individuals of certain races produce rarely a single peloric flower, an evidence De Vries considers of a semi-latent character which seldom becomes active. Seed from two such plants gave

out of a generation of two thousand one hundred plants, twenty plants having only peloric flowers. Progeny of these peloric plants gave ninety per cent. true to the type. In both *Chrysanthemum segetum* and *Linaria vulgaris peloria* self sterility made it difficult to grow pure line progenies. De Vries points out (1901, p. 564) that while he considers these as cases of mutation they are of a type quite different from that in *Oenothera*. In regard to the origin of such variations that are hereditary the evidence is not at all conclusive that slight variations may not be inherited even in a cumulative manner.

That this is the case is further suggested by the difficulty of drawing a definite line of distinction between species, varieties and races. De Vries, who has written most fully on this point from the standpoint of genetics, states that the best examples of varieties are those showing latency of a single character which may be just as constant as species (1901, p. 119); again he treats *O. nanella* (1901, p. 256) as a variety simply because somewhat similar dwarf types recur in a great number of species. He also gives the general view that varieties usually differ in one character (1901, p. 363); he states in another connection that the chief difference between improved races and species, even the smallest of elementary species, is the instability of the former and the stability of the latter (1901, p. 84); but we may note that inconstant species do occur (1901, p. 270).

It is clear that some cases of sporadic variation reproduce more true to type than others. The so-called law of mutation that "neue elementare Arten sind meist völlig constant, vom ersten Augenblicke ihrer Entstehung an" (1900, p. 175) is itself a qualified statement. The difficulty of assigning a definite heredity in terms of unit characters or unit factors to "newly born" characteristics which appear in mutations has become apparent. This is especially recognized in part by the view of Gates that mutation is a phenomenon of variability which is quite distinct from heredity.

Thus far progeny has been grown from only one of the dwarf plants of *Hibiscus oculiroseus*. One capsule of seed gave forty-six plants, all but one of which were dwarf, and another capsule gave twenty-seven dwarf, one robust and seven intermediates as judged

by the growth made the first year. The type appears to be only slightly inconstant. Further breeding tests will determine if the type becomes more constant by selection and if differences exist between the progenies of different dwarf plants.

There has been much discussion recently regarding the possibility of the association of hybridization with mutation especially in the Oenotheras. The rather well-known history of *Hibiscus oculiroseus* and its dwarf mutant is of significance in this respect. The wild form of *H. oculiroseus* was originally found in a region in which the species *H. Moscheutos* exhibits much polymorphism, involving problems which the writer now has under investigation. Its affiliations with this species are so evident that for some time it was known as a variety. The several differentiating characters possessed by *H. oculiroseus* have already been noted and while a few variations have been observed in my pedigreed cultures the species breeds remarkably true to type. In fact the only variations that have appeared have been among the progeny of the plant giving dwarf plants, and none of the variations suggest that this particular plant is a hybrid at least of the usual type. As far as now known, *H. oculiroseus* has a limited distribution in nature and since it is closely associated with *H. Moscheutos* it may well be that it has been derived from this species.

Mr. George William Bassett, owner of the William F. Bassett nurseries, writes in 1915: "We have never, to my recollection, observed any dwarf tendency in *Hibiscus* 'Crimson Eye.' Nor have we had any occasion to throw any out for any cause." It does not appear that dwarf forms have appeared in the cultivation of the species. Mr. Norman Taylor reports to the writer that he has observed in Long Island colonies of dwarf plants of the pink-flowered form of *H. Moscheutos*.

The evidence indicates that the dwarf form is of spontaneous origin. There is no series of characteristics belonging to either *H. Moscheutos* or the parent stock of *H. oculiroseus* that can be considered as combining to produce the dwarf, an interpretation given to the origin of *Oe. gigas* by Heribert-Nilsson (1912). The immediate parent (*O* No. 1) of the dwarf plants possessed in slight degree the characteristics of crinkled leaves and shortened inter-

nodes which later appeared more intensified in the dwarf plants. This, coupled with the variability of the progeny, might be considered by Mendelians to indicate that the parent plant was a half-mutant. While it is no doubt true that such cases do occur (a most notable case is that of *Oe. semigigas*), it is evident that the conception has been applied to many cases of irregular inheritance and sporadic variation and even to instances of cumulative variation.

A most important type of discontinuous variation is that of simultaneous variation in a group of characters, well illustrated by the dwarf *Hibiscus*. Not only is a number of characters modified but the habit of profuse branching from the base appears as a character quite new to the parent species. Such phenomena are not well explained on any conception of continuous unit characters.

Bateson does not admit that such simultaneous variation can occur as a sporadic variation. He does not believe in the mutation and inheritance of group-characters as described by De Vries and already mentioned with respect to characters of *Oe. nanella*. He prefers to think of the phenomena as due to a recombination of factors. His strongest evidence for this view is the apparent marked reversions that appear in certain crosses. If, however, recombinations can give new groups or develop characteristics new to the particular race and species, his analysis is of doubtful validity.

To assume that a variation such as the dwarf *Hibiscus* is due to a single change in a single hereditary unit is to assign to the units different values and to admit of interaction between units. On the other hand to assume that there are hereditary factors that are themselves stable but that can interact upon each other in various ways is to assign different values to the supplementary or coördinating units and to the various interactions between them. This makes the comprehensive description of the processes of heredity in terms of units other than characters of doubtful validity.

It is quite clear that hereditary variations giving dwarf forms of various degrees of intensity and extensity do arise. If in all cases single characters, factors or other hereditary units are con-

cerned the evidence is clear that they possess different potencies and belong to quite different categories, or else that they undergo quite different sorts of changes not only in different species but in the same species, variety, strain or even pure line.

The accumulation of evidence from all lines of plant breeding shows that sporadic and irregular expression and inheritance of characters are frequent and are widely distributed among plants, and that ordinary stable characters and combinations become split up and modified in processes of both mutation and hybridization, giving variability not conforming to the usual laws of fluctuating variability.

SUMMARY

A dwarf form of *Hibiscus oculiroseus* has appeared in a pedigreed culture as a sporadic variation. It differs from the robust form in possessing a smaller stature, shorter internodes, smaller leaves, many crinkled leaves and in the development of lateral branches from the base of the main stem.

Plants intermediate between the dwarf and the robust forms appear. These possess one or more of the characters of the dwarf type in some degree of development.

All the dwarf plants thus far obtained are the progeny of a single plant (*O* No. 1). No dwarf plants appeared among the 103 plants grown as progeny of four sister plants of plant No. 1.

The parent plant of this dwarf (*O* No. 1) possessed already in slight degree the characteristics of crinkled leaves and shortened internodes.

The dwarf plants appeared in varying numbers along with robust and intermediate types. One series (Series No. I) was composed of one dwarf, eleven robust and three intermediate plants; another series (Series VI) was composed of forty-five dwarf plants.

There is a strong tendency for the dwarf form to breed true. In a total of eighty-one plants grown from seed of a dwarf there were seventy-two dwarf plants, eight classed as intermediates, and one that was robust (Series VII and VIII).

It is difficult to describe the dwarf type in terms of characters that have been lost or gained. The smaller and crinkled leaves and the shortened internodes are evidences of reduced or arrested

growth. In the marked development of branches from the base there is increased growth or at least development of buds that usually remain dormant.

There is no series of characters of either *H. oculiroseus* or *H. Moscheutos* that can be considered as combining in hybridization to give the dwarf.

The simultaneous appearance of variations involving modifications of groups of characters and of intermediates of various kinds exhibit sporadic variations of various degrees of intensity quite in line with the general evidence of the sporadic nature and wide range of such variations.

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Explanation of plates 26-27

PLATE 26.

To the left, typical plant of the dwarf form of *Hibiscus oculiroseus* (Plant No. 14 of Series VIII). To right typical plant of the robust form (Plant No. 23 of Series IX). Photograph taken September 13, 1914. Both plants are seven months old.

PLATE 27.

View in garden. In center with marker in the midst is a series (Series VIII) of dwarf plants. Plant indicated at *a* is an intermediate. At the right is a series of hybrids between *H. oculiroseus* (Plant *O* No. 2) and the pink-flowered type of *H. Moscheutos*. To the left is part of a series of hybrids between white-flowered and pink-flowered forms of *H. Moscheutos*. The three series are of the same age and illustrate the difference between the dwarf and the robust forms.

A study of pasture trees and shrubbery

ERNEST L. SCOTT

(WITH THIRTEEN TEXT FIGURES)

Some years ago my attention was called to the peculiarly regular form of the thorn trees in the pastures of northeastern Ohio. These peculiar shapes are taken by the trees in response to the constant pruning to which they are subjected by the cattle. A very short study revealed the fact that other species are as characteristically affected as the thorns; this is especially true of wild apples, oaks and elms. Further, the behavior of each of the different types has features peculiar to itself. Many kinds of trees are not able to withstand the constant browsing to which they are subjected when growing in closely cropped pastures and so quickly disappear. On the other hand several species are not molested at all by the cattle. The "immunity" which is enjoyed by most nut-bearing trees seems to depend upon a taste or texture which is repugnant to the cattle. Whether or not this explanation is of wider application I do not know.

FIG. 1. A sugar maple found growing in an open pasture. The annual rings indicated an age of about 25 years. The maximum height was 45 cm. This tree appeared to be vigorous in every way and well able to maintain itself in this miniature form in spite of the cattle.

There is of course considerable variation in the relative abundance of the different species in the different pastures. But considering

the region as a whole the haws are the most conspicuous, not only because their striking contours but because of their number and size as well. Wild apples are frequently associated with the haws and resemble them so closely in form that the two species might easily be confused on superficial observation. Elms are very common in some pastures, but owing to the small size which they are able to attain they are inconspicuous, and would

FIG. 2. A haw in the second or spheroidal stage. This particular individual was 1.5 m. high and 2 m. in the greatest diameter. Though its age was not ascertained, other trees in the corresponding stage showed annual rings indicating an age of 10 to 20 years.

often escape the notice of the casual observer. The oaks seem to have partially solved the problems set for them by the cattle and by reason of their number and size demand attention. The hickories are, in general, avoided by the cattle and so are usually able to reach maturity when once started—at least so far as the cattle are

concerned. However, when they are attacked they usually succumb when the browsing is severe, but if the punishment is not too great they respond in a manner similar to that to be described for the oaks. Only two or three maples have been found which bear evidence of close cropping, not enough from which to draw conclusions (FIG. 1).

Since the thorns, wild apples, oaks and elms are the most numerous and are able to withstand the severe browsing to which they are subjected they are the most interesting types found. The points which I have considered are the forms taken by the several

FIG. 3. The third stage, an erect cone, of the haw. This one was 1.65 m. high and 1.8 m. in diameter at the base. The age might be anywhere from 10 or 20 years up.

species in response to browsing, and the means by which each finally gets beyond the reach of the cattle and so becomes independent.

The ability to withstand constant browsing is only one factor in determining the number of individuals of a species found in a

given pasture. The quantity of seed, the suitability of seed bed and soil, together with other conditions of growth, are quite as important.

The earliest form assumed by the haws as a direct result of the browsing is that of an inverted cone. This particular shape seems to result from the fact that when the tip of a branch is clipped off three or four buds situated short distances below the wound usually start to grow. These buds give rise to branches which elongate at about equal rates, each spreading somewhat from the old axis. Since the cattle trim all the axes which reach the surface and since the branches have a general tendency to grow upwards the plant assumes the form of an inverted cone. Gradually the lower branches are forced downward by the constantly increasing number of new axes formed so that a spheroidal shape may be assumed as shown in FIG. 2. When the lower branches are forced parallel to the ground the tree takes the form of an erect cone (FIG. 3). In grazing the cattle rarely bite the new growth back quite to the dead tips of the older branches, so that there is a gradual increase in size. The conical shape is maintained until the tree is of such a diameter that the center or apex is no longer reached by the cattle. The shoots which are now put out at the apex are free to grow without molestation. The exact duration of the cone stage depends upon the severity of the punishment to which the trees are subjected. In some pastures where the grazing is not severe there may be few or no cones found. In others which are pastured very closely practically all of the haws and apples present are in this condition or show distinct evidence of having passed through it. Under such conditions the plant may be compelled to remain in the cone stage for many years.

When the cattle are no longer able to reach the apex of the cone one or more axes quickly spring out so that we find a closely cropped cone with a loose clump of shoots projecting at its apex. This stage is shown in FIG. 4. In spite of the constant cropping of all new growth within the reach of the cattle, this protected clump rapidly increases both in height and diameter. But since above the reach of the cattle it is free to expand and an hour-glass shape soon results (FIG. 5). Trees in various stages are shown in FIG. 6.

Gradually the free portion of the tree extends beyond the lower branches. The lower portions are now shaded and finally are removed by self pruning until there results the usual rounded

FIG. 4.

FIG. 5.

FIG. 4. This haw had become of so great a diameter that the cattle could no longer reach its apex and so the shoots from this region were able to grow unmolested. This one was 3 m. high and of the same diameter at the base.

FIG. 5. The hour-glass form which is assumed by the haws after the apex has been able to grow for a few years without pruning.

head supported by a single trunk or perhaps by a group of two or three coordinate trunks. However the evidence of the struggle by which the tree has attained its adult shape is seldom quite lost.

FIG. 6. A common sight in pastures whose owner depends upon the cattle rather than the axe.

While the forms taken by the haws are perhaps more striking they are no more characteristic than those assumed by the oaks. Here as a rule only a single axis is developed, from the sides of which short branches are put out. Usually the topmost pair are longer than any of the others or if the browsing is particularly severe there may be a swelling at the top from which several branches arise (FIG. 7). Here the presence of dead stubs, indicating the axes which have been killed by the cattle is a striking feature. The head shown in FIG. 8 is typical of what is usually seen.

FIG. 7. An oak which represents the form typically assumed by this tree when browsed. This one was 12 years of age and had reached a height of 1.35 m. and a diameter of 0.7 m. There were seven annual rings just below the crotch.

The reason for the difference in habit between the oaks and the haws lies, I believe, in the fact that the oaks throw almost their whole strength of growth into a single bud so that when uninterrupted growth has been permitted by the cattle, even for a short time, some one axis will be seen to be much longer than any of the others. While, as has been shown, the growth of the haws is more diffuse, the number of axes increasing with the removal of each tip and all elongating at an approximately equal rate. As a matter of fact it appears that in general the oaks, when able to reach an independent stage at all, do so in fewer years than the haws. On the other hand the haws are able to stand the more severe punishment.

At times, when the terminal bud is greatly interfered with it may not be possible to identify the dominant axis. Evidence of the general tendency is, however, usually furnished by a study of the growth of successive years. Coupled with the emphasized growth of a single bud is the habit of putting out but few branches in response to the removal of the terminal portion of an axis.

The gnarled and bent forms which result from severe browsing may be converted into straight and erect trunks by a stronger growth over all concave surfaces than is found on the convex exposures. This together with the tendency of the growing points to assume the erect position is sufficient to conceal even such a head as the one shown in FIG. 8. During the process of straightening many of the dead stubs decay and are broken off so that they are overgrown. FIG. 9 shows a longitudinal section through a head similar to that shown in FIG. 7, made after this had long

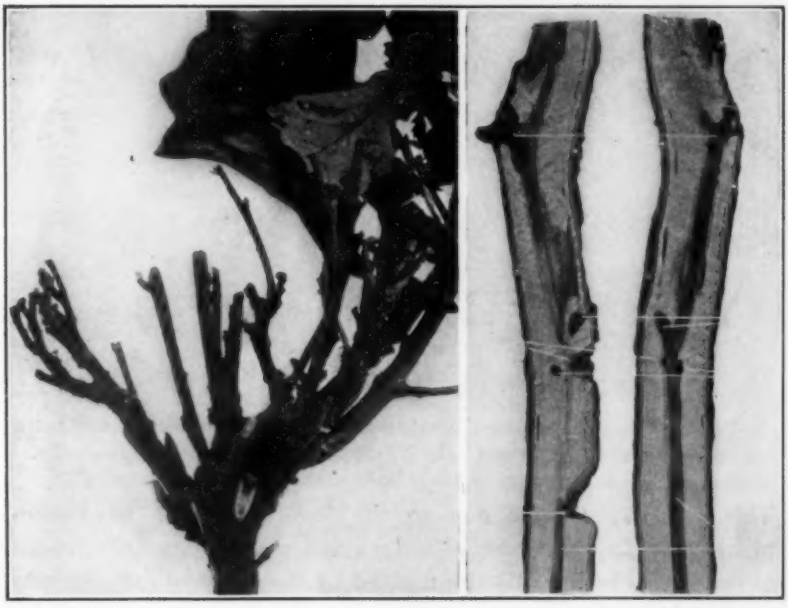

FIG. 8. FIG. 9.

FIG. 8. When the oaks are severely browsed they are frequently unable to maintain a successful growing axis until after many trials. The result is a globular head, from which project many dead and dying spikelike branches. These later drop off or are overgrown as shown in FIG. 9. About one third natural size.

FIG. 9. A longitudinal section through a head such as is shown in FIG. 8. This has long since ceased to be the point of conflict and the bases of the stubs are being overgrown and the stem straightened as described in the text. About one fourth natural size.

since ceased to be the point of contest and after the main axis had crowded all the others out of the field. The same means of

straightening is used by the other forms studied as well as by those oaks in which the grazing has been less severe. In FIG. 10 is shown a longitudinal section through the axis of an oak which has been subjected to severe browsing, but in which no head had been formed.

In walking through the pastures in which elms are common it is noted that almost all of the trees are 30–80 cm. in height.

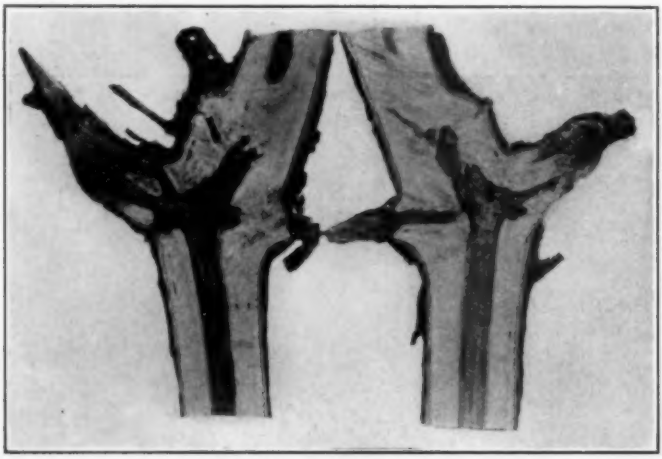

FIG. 10. Another instance of straightening, but in this case the browsing has not been so severe and there was no head formed. About one fourth natural size.

This is in many cases due to the fact that these trees commonly grow in the midst of sedges and reach about the height of the sedges before they are noticed by the cattle. They usually reach this height in two or three years and after this are not permitted to increase. Finally the upper portion of the stem dies from the continued cropping and a new shoot appears lower down on the axis or even from the roots and, under the protection of the dead or dying top, soon reaches the height of the latter when it in turn is subjected to severe browsing. There first results a form somewhat resembling that assumed by the oaks, a single stem with a number of side branches, FIG. 11. Finally, if the plant has sufficient vigor, a form is assumed resembling the first, or inverted cone stage, of the haws, FIG. 12. This results from branching and

development of shoots low down on the axis. An intermediate stage is shown in FIG. 13. While this shape appears much later in the elms, it is more accentuated and persistent than in the haws. This is because the branches of the elm have a more marked upward tendency and are not so readily induced to hug the ground as are the branches of the apples and haws. This upward tendency of the branches, together with the fact

FIG. 11. FIG. 12.

FIG. 11. This elm was in an early stage of the response to browsing. In spite of its age of 18 years, its height was only 61 cm.

FIG. 12. An elm that had been allowed to grow only 32 cm. in 17 years. The close branching and abundance of dead twigs indicate that it is well along in the inverted cone or second stage.

that an axis dies after certain amount of pruning, precludes the possibility of the formation of the spheroidal or of the erect conical form.

The elms are not in general able to reach the independent stage unaided. This is doubtless because they have the habits of growth of the haw but not the haw's vitality and ability to stand pruning. Though the elms are not able to reach independence unaided it must not be inferred that there are no elms which have obtained the independent stage in the pastures. An elm reaching up through

a clump of wild roses, a haw or a spice bush or even from the center of a group of less fortunate elms is a common sight.

In one plot of about 1.5 hectares sixty elms were counted, all of which were unprotected. Of these 90 per cent., or fifty-four, were less than 80 cm. in height and none were beyond the reach of the cattle. The tallest was 1.5 m. In another plot 50 m. square, 121 elms were found, seventeen of which were either protected at the

FIG. 13. An elm at a stage intermediate between those shown in FIGS. 11 and 12. But since it was growing in the open, i.e., was unprotected by sedges, it was only 20 cm. in height though it was 15 years of age.

time or had been at a time which permitted them to escape from the cattle. Of the 104 which were unprotected only two exceeded 1 m. in height and none were beyond the reach of the cattle. 80 per cent. of all the elms in this plot were below 1 m. in height and 23 per cent. enjoyed protection. In the same plot fifty oaks were found with only 56 per cent. below 1 m. and 12 per cent. unprotected.

SUMMARY AND CONCLUSIONS

1. The haws, apples, oaks, and elms are able to withstand constant browsing by cattle for a prolonged period of time.

2. In general other trees in pastures, as the ash, are killed within a few years; or they are avoided by the cattle, as the hickories and other nut-bearing trees.

3. When the tree is able to withstand the cropping for a long period it has good chances of reaching the natural size of the species. This is attained in different ways by the different species:

(*a*) The oaks throw the stress of growth into a single series of buds and so prolong the main axis at the expense of the lateral branches that the tip of this axis may be lifted beyond the reach of the cattle in comparatively few years.

(*b*) The haws and apples put out a large number of approximately equal branches forming a close network about the center of the tree, which is finally so far removed from the attacks of the cattle that it may grow unmolested. This is a much slower method than the one adopted by the oaks but seems to be somewhat surer as judged by the number of successful individuals.

(*c*) The elms have given up the attempt to reach independence without the help of some other plant but because of their persistence many of them are in time given the necessary protection.

4. While thorns are undoubtedly a factor in the escape of some species from the cattle their importance may easily be overestimated; the apples are apparently quite as successful as are the haws but are not provided with this armament

* * *

Kerner has described similar observations on the oak and beech but especially on the larch, as browsed by goats. Doubtless many others have observed related phenomena in pastural regions.

NEW YORK CITY.

Notes on Rosaceae—X

P. A. Rydberg

Rubus Hybrids

Hybrids are rather common in the genus *Rubus*, especially among the blackberries. Numerous hybrids have been admitted in Europe. The only really good attempt made to segregate hybrid forms in America, was that by Mr. Bicknell.* Mr. Bicknell studied these forms in the field and in most cases found the supposed parents growing in the immediate vicinity. I also have studied blackberry hybrids two summers in the Adirondacks, the Catskills, the mountains of southwestern Virginia, western North Carolina, and eastern Tennessee, and around Ottawa, Canada. It is a pity that it never occurred to Mr. Blanchard, who did so much valuable work on the blackberries, to explain the numerous forms as, partly at least, due to hybridity. It would not have been very hard to determine whether or not many of his new species probably had arisen through hybridizing. Mr. Bicknell, without having seen many of Mr. Blanchard's species in the field, reduced nearly all of them into hybrids or into synonyms of older species.

I think that his interpretation was correct in the majority of cases, but that he went too far in his reduction in some others. It is risky to make pronunciations without seeing the species in the field, and my course in the North American Flora was perhaps not so wise. It may have been better to leave many of the supposed species as such than to pronounce them as hybrids, without any better proofs than the finding of intermediate and intergrading characters. No definite conclusion can be had, however, without experimental work in crossing. The only alternative course to pursue would have been to admit all the proposed species as such and to describe twice as many more, most of them without any definite distinctive characters. In such a case, a key would have been impossible to make.

* Bull. Torrey Club **38**: 103–133. 1911.

The following ninety-three tentative hybrids have been recorded. Their essential characters have been pointed out in the North American Flora, but in that work no specimens are cited, except the types of new species and the first records of new hybrids. It is, however, valuable to students of the brambles to know what specimens the monographer regarded as such hybrids. I have, therefore, prepared the following list of specimens.

Rubus acaulis × *stellatus.*

ALASKA: 1885, *Huff;* Copper Center, *Heidman 88.*

Rubus acaulis × *pubescens. Rubus propinquus* Richardson is regarded as a synonym of this.

MACKENZIE: Hay River, July 1, 1903, *Preble & Cary 25;* wooded country, *Richardson.*

Rubus arcticus × *pubescens.**

QUEBEC: Mt. Albert, Gaspé County, 1906, *Fernald & Collins 623a;* Table-top Mountain, *Fernald & Collins 617.*

Rubus arcticus × *saxatilis* (*R. castoreus* Frees). No locality has been recorded on this side of the Atlantic, but it may be expected in northeastern Canada.

Rubus idaeus × *spectabilis.* This is unknown except as a garden plant, and it is natural that it should be so, as *Rubus idaeus* and *R. spectabilis* have no common territory where both grow wild. Indigenous hybrids of *R. spectabilis* and species related to *R. idaeus* have been collected in Alaska, viz., the two following:

Rubus spectabilis × *viburnifolius.*

ALASKA: Lake Clark, 1902, *Gorman.*

Rubus spectabilis × *subarcticus.*

ALASKA: Camp 53, 1899, *Shrader.*

Rubus occidentalis × *rosaefolius.* Known only as a garden hybrid.

Rubus idaeus × *ursinus.* Only known as a spontaneous garden hybrid, which is under cultivation as the Logan Berry.

Rubus idaeus × *phoenicolasius. R. Paxii* Focke. Only known as a garden hybrid.

* In answer to a letter to Dr. Fernald suggesting that the plant collected by him and Mr. Collins was a hybrid, I received the following reply: "I have no doubt that the plants you refer to are hybrids of *Rubus triflorus* and *arcticus.* Such specimens are found in small colonies throughout Gaspé, Newfoundland, and southern Labrador, wherever *R. arcticus* occurs."

Rubus occidentalis × *strigosus* (*R. neglectus* Peck; *Melanobatus neglectus* and *M. michiganus* Greene). This is a rather common hybrid and it would be superfluous to cite specimens. Sometimes it resembles more one parent, sometimes the other. The original *R. neglectus* is most like *R. occidentalis*, while *Melanobatus michiganus* approaches *R. strigosus*.

Rubus occidentalis × *procumbens*. The very interesting plant, which I referred to this hybrid, was collected by Commons nearly forty years ago. Commons recognized it as a hybrid of *R. occidentalis* but made no suggestion of the other parent. This is evidently a member of the *Eubatus* section, apparently to be sought among the dewberries, and most likely *R. procumbens*. Mr. Commons remarks: "I tried to perpetuate this by sowing the seeds at various times, but not one came up."

Rubus leucodermis × *melanolasius*.

BRITISH COLUMBIA: near international boundary between Kettle and Columbia River, *J. M. Macoun 64002;* Chilliwack Valley, *J. M. Macoun 34805;* also *7035* and *69970* from British Columbia.

MONTANA: Belton, 1903, *Umbach 698;* McDonald's Lake, 1909, *M. E. Jones*.

OREGON: Eastern Oregon, 1897, *Cusick 1729*.

WASHINGTON: 1897, *Horner 163*.

Rubus macropetalus × *viburnifolius*. No other specimen but the original one, *Mr. & Mrs. C. Van Brunt 121*, from Glacier, British Columbia, has been seen of this hybrid.

Rubus idaeus × *strigosus*. This is not uncommon in cultivation, but no record of it in a wild state has been made.

Rubus argutus × *cuneifolius*. This was first recognized as a hybrid by Mr. Bicknell. The same form had also been collected by Britton & Hollick, who did not venture to name it. Their specimens were determined as *R. Andrewsianus* by Mr. Blanchard, but the dense grayish pubescence of the under leaves is not found in that species. All the specimens seen are from the sandy coast strip.

NEW JERSEY: Atlantic Highlands, 1906, *Hollick & Britton;* Toms River, 1900, *Bicknell 90*.

Rubus cuneifolius × *floridus*. What I regard as this hybrid is one much resembling the last hybrid but a weaker plant with more curved prickles. Judging from the analogy, it is not improbable that this plant is such a hybrid, as it differs from *R. argutus* × *cuneifolius* in the same characters as does *R. floridus* from *R. argutus*, and both *R. floridus* and *R. cuneifolius* are found in the district where the supposed hybrid has been found. Mr. Ashe distributed it mixed with *R. cuneifolius*.

VIRGINIA: Ocean View, Norfolk, 1898, *Kearney 1212*.

NORTH CAROLINA: Chapel Hill, *Ashe*, mixed with *R. cuneifolius*.

Rubus cuneifolius × *lucidus*. Mr. Nash collected specimens near Eustis, Florida, which resemble *R. cuneifolius* in many respects, but the leaves are larger, more acute and more coarsely serrate. He determined them doubtfully as *R. cuneifolius*. Similar specimens were also collected by Chapman, in Duval County, Florida, together with *R. cuneifolius*. He also has collected *R. lucidus* in the same county.

FLORIDA: Duval County, *Chapman 2832*, mostly; Eustis, 1894, *Nash 70*.

Rubus cuneifolius × *trivialis*. Somewhat similar specimens were collected by Coker at Hartville, South Carolina, but in these the plant is prostrate, the flowers mostly solitary, and in habit it resembles more *R. trivialis*. These specimens I regard as *R. cuneifolius* × *trivialis*.

Rubus canadensis × *sativus*. The specimens which I regard as this hybrid were originally labeled *R. canadensis*, but Mr. Blanchard has afterwards written on the sheets "A var. or form of *R. can.* W. H. B." It is evidently not pure *R. canadensis* for the inflorescence is glandular and the leaflets of the new shoots are broadly cordate and abruptly acuminate as in *R. sativus*.

VERMONT: Windham, June 6, 1903, *Blanchard 265*.

Rubus nigricans × *sativus*. I have no positive evidence that *R. frondisentis* Blanchard is such a hybrid, but the plant combines characters of the two species, and is found where the ranges of the two species overlap. It is also a very local plant and has not been collected except at the original station.

Rubus argutus × *nigrobaccus*. This hybrid was first recog-

nized by Mr. Bicknell, but he used the name *R. allegheniensis* × *argutus*, following Blanchard and Fernald in interpreting *R. allegheniensis*. The plant is not uncommon and the following specimens are referred here.

NEW YORK: Lynbrook, Long Island, 1901, *Bicknell 36;* Elizabethtown, Essex County, 1900, *Macy;* Bronx Park, 1896, *Nash;* Highland Falls, 1910, *Mearns 50.*

MASSACHUSETTS: Quaise, Nantucket Island, 1910, *Bicknell 33;* Shawaukemmo Spring, Nantucket Island, *Bicknell 35;* Canton, near Boston, 1906, *Blanchard 99, set 9.*

VIRGINIA: Rosslyn, 1897, *Kearney.*

CONNECTICUT: Southington, 1904, *Andrews 3.*

PENNSYLVANIA: Tannersville, 1901, *Britton.*

NEW JERSEY: Clifton, 1890, *Nash 900;* Paramus Swamp, Bergen County, *Nash 947;* also *Mackenzie 2086.*

Rubus frondosus × *nigrobaccus*. This was also first recognized as a hybrid by Bicknell, although he included in it specimens which I do not think belong to it but rather to *R. nigrobaccus* × *recurvans*. It was not at all unnatural that he should do so, as he did not recognize *R. recurvans* as a distinct species.

MASSACHUSETTS: Shawaukemmo Spring, Nantucket Island, 1908, *Bicknell 20.*

NEW YORK: Jamaica, Long Island, 1901, *Bicknell 25;* Port Washington, *Bicknell 21, 23;* Franklin Square, *Bicknell 19.*

PENNSYLVANIA: north of Philadelphia, 1906, *Blanchard 100, Set 6;* Lancaster County, 1894, *Ely.*

NEW JERSEY: Succasunna, 1909, *Mackenzie 4123.*

Rubus canadensis × *nigrobaccus*. This hybrid was first recognized by myself when I studied the blackberries in the Catskills, 1906, at Tannersville, where it grew together with *R. nigrobaccus* and *R. canadensis*. I also saw it in the Adirondacks and in southwestern Virginia.

NEW YORK: Tannersville, 1906, *Rydberg 7974;* Little Moose Lake, 1906, *Rydberg 7820a;* Stanford, 1909, *Taylor 712;* Tannersville, 1892, *Vail;* North Harpersfield, *Topping 132.*

MASSACHUSETTS: Tyringham, Berkshire County, 1897, *Vail.*

VERMONT: Grafton, 1902, *Blanchard 177;* Simonsville, *Blanchard 183;* Rutland, 1902, *Eggleston 2884.*

VIRGINIA: White Top Mountain, 1908, *Rydberg 8104;* between Marion and White Top Mountains, *Rydberg 8138.*

NORTH CAROLINA: Graham County, 1897, *Biltmore Herbarium 1307c.*

NEW BRUNSWICK: Grand Falls, *Macoun 21181.*

Rubus amicalis × *nigrobaccus.* Comparing the specimens referred here with *R. canadensis* × *nigrobaccus,* I came to the conclusion that this must be a hybrid of the species mentioned. They were collected by Arthur at Isle au Haut, Maine.

Rubus nigrobaccus × *Randii.* This was first recognized by myself while collecting in the Adirondacks. Both parents grew in the vicinity. Subsequently I thought it was the same as *R. frondisentis* Blanchard, but I have found it is not. None except the original specimens have been seen.

Rubus nigrobaccus × *pergratus.* The following specimens I think belong to this hybrid. They were collected near the type locality of *R. amicalis* × *nigrobaccus. Rubus pergratus* is also common in the region.

MAINE: Isle au Haut, 1909, *Arthur 55, 56.*

Rubus heterophyllus × *nigrobaccus.* I have no evidence that the specimens referred here belong to a hybrid except that the plant combines the habit and glandular pubescence of *R. nigrobaccus* with the leaf cut of *R. heterophyllus.* The original specimens are the only ones seen.

Rubus nigricans × *nigrobaccus.* This I collected at Kingsmere Lake, Quebec, where both *R. nigricans* and *R. nigrobaccus* were growing. I have no doubt but my specimens were of hybrid origin. I cannot distinguish them from specimens of *R. glandicaulis* distributed by Mr. Blanchard. *R. biformispinus* Blanchard I think is also a hybrid of the same two species, though approaching *R. nigricans* more than *R. nigrobaccus.* The following specimens belong here:

QUEBEC: Kingsmere Lake, 1906, *Rydberg 7946.*

NEW BRUNSWICK: Frederickstown, *Blanchard 606.*

MAINE: Yarmouth, 1909, *Blanchard 507;* Brownville, *Blanchard 508;* Bar Harbor, *Blanchard 509;* Calais, *Blanchard 510;* Isle au Haut, 1909, *Arthur 52;* Kennebunk, 1905, *Blanchard 74, Sets 1, 2;* Kennebunkport, 1905, *Blanchard 79.*

NOVA SCOTIA: Granville, 1909, *Blanchard 718, 727;* Yarmouth, *Blanchard 728.*

Rubus nigrobaccus × *vermontanus.* If *R. glandicaulis* is a hybrid between *R. nigrobaccus* and *R. nigricans, R. frondisentis* is very likely a hybrid between the former and *R. vermontanus.*

VERMONT: Townshead, 1903 and 1904, *Blanchard 243, 244;* Huntington, 1903, *Blanchard 257.*

Rubus hispidus × *nigrobaccus. R. permixtus* Blanchard stands in the same relation to *R. hispidus* as *R. glandicaulis* does to *R. nigricans,* I therefore do not hesitate in regarding it as a hybrid between *R. nigrobaccus* and that species.

VERMONT: Westminster 1902 and 1903, *Blanchard 225, 226, 227, 229;* Putney, 1902, *Blanchard 228;* Westminster, 1903, *Eggleston 3245.*

NEW HAMPSHIRE: Walpole, 1903, *Blanchard 233.*

NOVA SCOTIA: *Macoun 81438, 81439.*

Rubus argutus × *frondosus.* This was first recognized by Mr. Bicknell.

NEW YORK: Rockville Center, Long Island, 1906, *Bicknell 38;* between Yonkers and Mount Vernon, 1902, *Burnham.*

CONNECTICUT: Southington, 1905, *Blanchard 99, set 1;* 1904, *Andrews 27.*

Rubus argutus × *recurvans.* This was included in *R. argutus* × *frondosus* by Bicknell, who did not regard *R. frondosus* and *R. recurvans* distinct.

MASSACHUSETTS: Quaise, Nantucket Island, 1909, *Bicknell 34.*

NEW YORK: Cedarhurst, Long Island, 1910, *Bicknell 37.*

Rubus argutus × *Baileyanus.* This was also segregated out by Mr. Bicknell.

MASSACHUSETTS: below the "Cliff," Nantucket Island, 1910, *Bicknell 40.*

NEW YORK: East Rockaway Bog, Long Island, 1908, *Bicknell 41;* also at Hawlett, *Bicknell 42.*

Rubus argutus × *Enslenii.* This was also recognized by Mr. Bicknell, although he did not publish the same. His specimens closely match the type of *R. ostryifolius* Rydb., which I now do not hesitate in regarding as this hybrid.

NEW YORK: Hempstead Plains, Long Island, 1910, *Bicknell 65;* Lynbrook, *Bicknell 62, 64, 66.*

NEW JERSEY: Highlands, *Britton;* Ogdensburg, 1910, *Mackenzie 4625;* South Amboy, 1905, *Mackenzie 1376.*

VIRGINIA: Norfolk, 1898, *Kearney 1365.*

Rubus argutus × *carpinifolius.* Both Engelmann and Bailey recognized this as a hybrid, regarding one of the parents as *R. trivialis* from which *R. carpinifolius* was not separated at that time. Bailey thought that the other parent was *R. argutus.* Engelmann gave it as *R. villosus,* under which name both *R. argutus* and *R. nigrobaccus* were then known.

MISSOURI: St. Louis, 1863, *Engelmann;* Cahokia, 1863, *Engelmann.*

Rubus floridus × *lucidus.* In the description of *R. persistens* Rydb. two different plants were included. Unfortunately, it happened that the specimen which was assigned as the type evidently belongs to a hybrid of *R. floridus* and a species then unknown. *R. persistens,* therefore, must pass into synonymy.

Rubus carpinifolius × *floridus.* Dr. Engelmann regarded the original specimen of this hybrid as a variety of *R. trivialis.* It is more likely that it is a hybrid of *R. carpinifolius,* which at his time was not distinguished from *R. trivialis,* and *R. floridus,* which is also found in Texas.

TEXAS: Houston, 1842, *Lindheimer.*

Rubus floridus × *frondosus.* Some specimens collected at Bluff Lake, Missouri, by Eggert probably belong to a hybrid between *R. floridus* and *R. frondosus.* The only reason for believing so is that they combine characters of both and were found in a region common to both.

MISSOURI: Bluff Lake, *Eggert.*

TENNESSEE: Knoxville, 1896, *Ruth.*

Rubus Enslenii × *frondosus.* This was first recognized by Mr. Bicknell and well described by him.

NEW YORK: Hempstead Plains, Long Island, 1906, *Bicknell, 48, 49, 70.*

MASSACHUSETTS: Nantucket Island, 1906, *Bicknell 47.*

Rubus frondosus × *procumbens.* I have no definite evidence

that *R. Rossbergianus* is a hybrid of *R. frondosus* and *R. procumbens*, but the habit is intermediate between the two; the leaves resemble in form those of *R. frondosus*, but are harsher; and the stem is light colored, tough and prickly as in *R. procumbens*. Both are found in the region.

CONNECTICUT: Southington, 1905, *Blanchard 89, set 1–3;* Graniteville, *Blanchard 89, set 3;* Canton, *Blanchard 89, set 5;* Southington, 1904, *Andrews 21, 22, 23, 31, 33, 35.*

NEW JERSEY: Tuckerton, *Mackenzie.*

Rubus frondosus × *hispidus.* Also one of Mr. Bicknell's hybrids, collected only at the original station and vicinity, *Bicknell 43, 69.*

Rubus canadensis × *recurvans.* The specimens from which *R. recurvans subrecurvans* was described approach *R. canadensis* L. in so many respects, such as the form of the leaves, the inflorescence, and the weakly developed armature of the stems, that I have regarded it as a hybrid with that species.

MAINE: Kennebunkport, 1905, *Blanchard 71;* York Beach, 1909, *Blanchard 516.*

Rubus Brainerdi × *vermontanus.* The specimens referred to this hybrid were collected at the type station of *R. Brainerdi* and together with it. *R. vermontanus* is common in the region.

VERMONT: Weybridge, *Brainerd;* also 1902, *Eggleston 2894.*

Rubus amicalis × *pergratus.* No specimens except the original ones have been seen.

Rubus argutus × *canadensis.* This was first recorded by myself from southwestern Virginia, but similar specimens have also been collected in the north.

VIRGINIA: road between Marion and White Top Mountain, 1908, *Rydberg 8099;* Chattam Hill Road, 1892, *Small.*

NORTH CAROLINA: Biltmore, 1909, *Crafton & Eggleston, 4416.*

NEW JERSEY: Greenwood Lake, 1907, *Mackenzie 2675;* Ogdensburg, 1910, *Mackenzie 4625.*

Rubus canadensis × *Randii.* This was first recorded by myself from the Adirondacks, where both parents grow.

NEW YORK: Little Moose Lake, 1906, *Rydberg 7818; 7820;* Twin Lakes, *Rydberg 7842;* East Lake, *Rydberg 7861.*

NOVA SCOTIA: Pictou, 1906, *C. B. Robinson 528.*

Rubus canadensis × *pergratus.* Also first recorded by myself at Tannersville, New York, *7960, 7961.*

Rubus Baileyanus × *canadensis.* The specimens originally recorded as this hybrid were collected near an artificial lake or reservoir above Sparta, New Jersey. *R. canadensis* was growing in the neighborhood but *R. Baileyanus* was not collected there. The habit of the plant and the poor fruiting indicate a hybrid of *R. canadensis* and, probably, *R. Baileyanus.* To this belong:

NEW JERSEY: Morris Lake, Sparta, 1906, *Rydberg 7992;* Montague Township, Sussex County, 1909, *Nash;* Midvale, 1908, *Rydberg 8016.*

NOVA SCOTIA: *Macoun 81433, 81431.*

Rubus elegantulus × *nigrobaccus. Rubus flavinanus* Blanchard evidently represents this hybrid. The plant is decidedly intermediate between the two. None except Blanchard's specimens have been seen.

Rubus Baileyanus × *nigrobaccus.* This was first recognized as a hybrid by Mr. Bicknell, who, however, did not publish the same. The following specimens belong here:

NEW YORK: Smithtown, Long Island, 1910, *Bicknell 17, 24.*

PENNSYLVANIA: Presque Isle, Erie, *Otto Kuntze 2671.*

NEW JERSEY: Midvale, 1908, *Rydberg 8017.*

Rubus Baileyanus × *procumbens.* This has been known for fifteen years or more and is even in cultivation, but it was first regarded as a variety of *R. procumbens,* and later as a distinct species under the name *R. roribaccus.* Mr. Bicknell was the first one to recognize it as a hybrid. Some of his specimens match very closely the original ones distributed by Professor Bailey.

MASSACHUSETTS: Nantucket Island, 1910, *Bicknell 8.*

NEW YORK: Cedarhurst, Long Island, 1910, *Bicknell 6;* Aqueduct, 1905, *Bicknell 7.*

NEW JERSEY: Ledgewood, 1909, *Mackenzie 4127;* Succasunna, *Mackenzie 4126.*

VIRGINIA: Glade Springs, 1908, *Rydberg 8148;* Fairfax, 1906, *Blanchard 101, set 3.*

PENNSYLVANIA: Willow Grove Park, 1906, *Blanchard 101, set 2;* Lancaster, *Blanchard 101, set 1.*

CONNECTICUT: Southington, 1906, *Blanchard 101, set 5½.*

MISSOURI: Little Blue Tank, 1897, *Mackenzie 210.*

IOWA: Papoose Creek, 1894, *Mackenzie 681.*

Rubus Baileyanus × *frondosus.* First segregated by Mr. Bicknell.

MASSACHUSETTS: Quaise, Marcy's Pond, below the "Cliff," and Squam, Nantucket Island, 1910, *Bicknell 85, 86, 88, 87, 84.*

NEW JERSEY: Budd's Lake, 1905, *Eggleston 0;* Mt. Arlington, 1905, *Mackenzie 1402;* Stanhope, *2085;* Berkeley Heights, *2047.*

Rubus Baileyanus × *hispidus.* This was at first included in *R. hispidus* × *procumbens* by Bicknell. He, however, determined his Long Island material as *R. Baileyanus* × *hispidus.*

NEW YORK: Aqueduct, Long Island, 1905, *Bicknell 73.*

NEW JERSEY: near Musconetcony River, 1906, *Mackenzie 2107.*

MASSACHUSETTS: Reed Pond, Nantucket Island, 1910, *Bicknell 75;* Reading, 1897, *Kingman.*

Rubus Baileyanus × *carpinifolius.* Another plant collected by Eggert at Bluff Lake, Missouri, in 1878 must be, on account of the combination of characters, a hybrid between *R. Baileyanus* and *R. carpinifolius,* which both grow in the region.

Rubus arenicola × *hispidus.* The original specimens are the only ones seen of this hybrid.

Rubus nigrobaccus × *plicatifolius.* The specimen referred to this hybrid (*Blanchard 516,* sheet 1), was labeled by Mr. Blanchard *R. recurvans* var. *subrecurvans,* which variety I regard as a hybrid between *R. recurvans* and *R. canadensis;* but this number evidently does not belong there. The glandular pubescence of the inflorescence and the cut of the leaves in the specimens mentioned indicating *R. nigrobaccus* blood. The pubescence and the plication of the leaves suggest *R. plicatifolius.*

Rubus nigricans × *plicatifolius.* I regard *R. multiformis* Blanchard as a hybrid of *R. nigricans* and *R. plicatifolius.*

NOVA SCOTIA: Yarmouth, 1909, *Blanchard 724;* Annapolis *Blanchard 726;* Kentville, *Blanchard 725.*

MAINE: Bar Harbor, 1909, *Blanchard 512;* Kennebunkport, 1905, *Blanchard 80.*

QUEBEC: *Macoun 67904.*

Rubus canadensis × *plicatifolius.* The almost unarmed stem of *Rubus multiformis delicatior* Blanchard indicates a hybrid of *R. canadensis.* The plicate leaves suggest *R. plicatifolius.*

MAINE: Kennebunkport, 1905, *Blanchard 81.*

NOVA SCOTIA: Halifax, *Macoun 81426.*

Rubus hispidus × *plicatifolius. Rubus semierectus* Blanchard I take as a hybrid. The small flowers, bristly stem and broad leaflets suggest *R. hispidus,* the pubescent strongly veined and subplicate leaflets, *R. plicatifolius.*

MAINE: Kennebunk, 1905, *Blanchard 67.*

NEW YORK: vicinity of Tannersville, 1891, *Vail.*

NOVA SCOTIA: *Macoun 5792, 19076.*

Rubus heterophyllus × *recurvans.* No other specimens than those cited in the North American Flora, viz., *Blanchard 256,* from Huntington Hills, Massachusetts, have been seen which may be referred to this hybrid.

Rubus argutus × *flagellaris.* This as well as all the other hybrids of *R. flagellaris* were discovered by Mr. Bicknell. For specimens and notes see his paper in the Bull. Torrey Club **38**: 103–133, 1911. The other hybrids are *Rubus flagellaris* × *frondosus, R. flagellaris* × *procumbens, R. Baileyanus* × *flagellaris, R. flagellaris* × *hispidus* and *R. flagellaris* × *Enslenii.*

Rubus nigrobaccus × *procumbens.* This was first recognized by Mr. Bicknell, but under the name *R. allegheniensis* × *procumbens.*

NEW YORK: Merrick, Long Island, 1910, *Bicknell 30;* Hewlett, *Bicknell 28;* Lynbrook, *Bicknell 26.*

MASSACHUSETTS: Wauwinet, Nantucket Island, 1910, *Bicknell 27.*

Rubus argutus × *procumbens.* This was also first recognized as a hybrid by Bicknell. *Rubus multispinus* Blanchard matches Bicknell's specimens very closely.

NEW YORK: Rockville Center, Long Island, 1909, *Bicknell;* Hewlett, *Bicknell 68;* Lawrence, *Bicknell 67.*

MASSACHUSETTS: Nantucket Island, 1899, *Bicknell 29;* 1910, *Bicknell, 82, 83;* Reheboth, 1906, *Blanchard 96, set 2;* Plymouth, 1906, *Blanchard 96, set 3.*

RHODE ISLAND: Rocky Point, 1906, *Blanchard 96, set 1.*

Rubus procumbens × *recurvans.* Many specimens from Connecticut resemble *R. procumbens* closely, but are more pubescent and with the leaves of the floral branches more incised. These I have regarded as hybrids with *R. recurvans.* They are:

CONNECTICUT: Southington, 1904, *Andrews 29, 28, 41, 61, 37, 34, 30;* Plainville, 1903, *Blanchard 222;* Winsted *Blanchard, 259.*

MASSACHUSETTS: Southwick, 1903, *Blanchard 253.*

Rubus pergratus × *procumbens. Rubus recurvicaulis* Blanchard seems to me a hybrid of *R. pergratus* and *R. procumbens,* combining characters of both. I have seen no specimens except those distributed by Mr. Blanchard.

Rubus canadensis × *procumbens. Rubus recurvicaulis inarmatus* stands to *R. canadensis* as *R. recurvicaulis* does to *R. pergratus,* and I believe also this to be a hybrid.

MAINE: Kennebunk, 1905, *Blanchard 67, 69.*

NOVA SCOTIA: North Sidney, 1907, *C. B. Robinson 616.*

Rubus hispidus × *procumbens.* This was first recognized by Mr. Bicknell. The following specimens belong here:

NEW YORK: Cypress Hill, 1905, *Bicknell 74.*

VERMONT: Londonderry, 1903, *Blanchard, 246;* Newfane, 1902, *Blanchard 186.*

NOVA SCOTIA: Boylston, 1890, *Chas. Hamilton, 19985.*

NEW JERSEY: Mt. Arlington, 1905, *Mackenzie 1404;* also 1904, *Mackenzie 903.*

Rubus Baileyanus × *Enslenii.* Also one of Mr. Bicknell's hybrids.

MASSACHUSETTS: Nantucket Island, 1908, *Bicknell 52, 54, 55.*

CONNECTICUT: New Haven, 1895, *Helen Ingersoll.*

NEW YORK: Woodmere, 1904, *Bicknell 56.*

DISTRICT OF COLUMBIA: Riverdale, 1901, *Steele.*

VIRGINIA: Marion, *N. L. & E. G. Britton & A. M. Vail.*

Rubus Enslenii × *procumbens,*

Rubus Baileyanus × *Enslenii,*

Rubus Enslenii × *flagellaris,* and

Rubus Enslenii × *hispidus.* Of these four hybrids, I have seen none but Mr. Bicknell's specimens. See Bull. Torrey Club 38: 130–131. 1911.

Rubus argutus × *nigricans*. I cannot distinguish *R. adscendens* Blanchard from Mr. Bicknell's hybrid. The following specimens belong here:

NEW YORK: Smithtown, Long Island, 1808, *Bicknell 89*.

NEW JERSEY: Allamuchy Mountains, 1906, *Mackenzie 2108, 2300;* Succasunna, 1909, *Mackenzie 4153*.

CONNECTICUT: Southington, 1906, *Blanchard 90;* 1903, *Blanchard 262, 224;* Londonderry, *Blanchard 246;* 1904, *Andrews 53, 57, 56*.

MASSACHUSETTS: Essex County, *Oakes*.

Rubus frondosus × *nigricans*. From this I cannot separate *Rubus abbrevians* Blanchard. The following specimens belong here:

MASSACHUSETTS: Long Pond and Trot's Swamp, Nantucket Island, 1910, *Bicknell 31, 32*.

CONNECTICUT: Southington, 1906, *Blanchard 95*.

VERMONT: Windham, 1904, *Blanchard 57*.

PENNSYLVANIA: Germantown, *Meehan 8679*.

Rubus nigricans × *recurvans*. *R. semisetosus* Blanchard I regard as a hybrid between *R. nigricans* and *R. recurvans*. The following specimens belong here:

CONNECTICUT: Southington, 1903, *Blanchard 201, 202, 225;* Londonderry, *Blanchard 247;* Plainville, 1906, *Blanchard 91, set 1;* also 1903, *261, 203*.

RHODE ISLAND: Rocky Point, 1906, *Blanchard 91, set 3*.

NOVA SCOTIA: Sable Island, *Macoun 21193, 21183* (these specimens are doubtful).

Rubus amicalis × *nigricans*. *Rubus tardatus* Blanchard is probably also a hybrid, the parents being *R. amicalis* and *R. nigricans*. Mr. Blanchard's specimens are the only ones seen.

Rubus nigricans × *pergratus*. In my opinion *R. peculiaris* Blanchard is also a hybrid, viz., of *R. nigricans* and *R. pergratus*. Besides Mr. Blanchard's specimens the following belong here:

QUEBEC: vicinity of Montmorency Falls, 1905, *Macoun 67904, 67905*.

Rubus canadensis × *nigricans*. *Rubus junceus* Blanchard is probably also a hybrid. Besides the specimens distributed by Mr. Blanchard, the following are referred to it.

ONTARIO: Cranberry Lake, Algonquin Park, 1900, *Macoun 24696a*.

MAINE: Sangerville, 1895, *Fernald 244*.

Rubus nigricans × *Randii*. Only the specimens of the original collection have been recorded.

Rubus Baileyanus × *nigricans*. This was first recognized by Mr. Bicknell. C. C. Curtis's specimens have much narrower leaflets and are doubtfully referred to it.

NEW YORK: Hempstead Plains, 1910, *Bicknell 15;* between Yonkers and Mount Vernon, 1903, *C. C. Curtis;* Van Courtlandt Park, 1896, *Bicknell*.

CONNECTICUT: Plainville, 1904, *Andrews 26;* Southington, 1903, *Blanchard 237* (determined as *R. semisetosus*).

Rubus flagellaris × *nigricans*. This was collected by Mr. Bicknell, who included it in *R. nigricans*. The following specimens so named I refer to the hybrid instead.

MASSACHUSETTS: Little Neck, Millbrook Swamp and Long Pond, Nantucket Island, 1910, *Bicknell X, XX, XXX*.

Rubus nigricans × *procumbens*. This was also recognized as a hybrid although he did not describe the same. The following specimens belong to it:

NEW YORK: East Hempstead, Long Island, 1910, *Bicknell 16;* Jamaica, 1906, *Bicknell 18*.

CONNECTICUT: Plainville, 1904, *Andrews 55;* Southington, *Andrews 54, 57, 58, 59, 62*.

VERMONT: Londonderry, 1903, *Blanchard 245* (referred doubtfully to *R. vermontanus*).

NOVA SCOTIA: *Macoun 81425;* Sable Island, *Macoun 21193*.

Rubus nigricans × *vermontanus*. *Rubus vermontanus viridifolius* has glandular hispid inflorescence and I therefore believe it contains some *R. nigricans* blood in it. I therefore regarded it as a hybrid. Many specimens referred to *R. setosus* by Blanchard belong here:

VERMONT: Marlboro, 1902, *Blanchard 191;* Woodstock, 1910, *Britton;* Stockbridge, 1897, *Eggleston;* West Windham, 1904, *Blanchard 59, set 1;* Stratton, *59, Blanchard, set 2;* Rutland, 1899, *Eggleston 1228*.

NEW YORK: Tannersville, 1906, *Rydberg 7954*.

NEW HAMPSHIRE: Alstead, 1903, *Blanchard 236, 234, 235*.

MAINE: Biddeford, 1905, *Blanchard 86*.

QUEBEC: East Templeton, 1903, *Macoun 59963*.

Rubus hispidus × *nigricans*. Mr. Bicknell found this very variable, sometimes approaching one parent, sometimes the other. My observations agree very well with his. Often the plant resembles a robust *R. hispidus*, but with the leaflets of the new shoots having a tendency often to be five instead of three. It is then *R. hispidus major* Blanchard. Sometimes it resembles more *R. nigricans* in habit. If the leaflets of the new shoots happen to be only three, it is *R. trifrons* Blanchard. The following represent *R. hispidus major:*

CONNECTICUT: Southington, 1904, *Andrews 60;* Botsford, 1897, *Eames*.

MAINE: Kennebunkport, 1905, *Blanchard 84;* Kennebunk, *Blanchard 85*.

NOVA SCOTIA: Cape Breton, 1901, *Howe & Lang 748;* Pictou, 1907, *C. B. Robinson 574, 494*.

MASSACHUSETTS: 1879, *Perkins*.

PENNSYLVANIA: Pocono Plateau, 1893, *Britton*.

NEW YORK: Tannersville, 1908, *Rydberg 8037*.

Specimens resembling *R. trifrons* are the following:

VERMONT: West Wadsboro, 1904, *Blanchard 55;* Stratton, 1902, *Blanchard 198*.

NEW YORK: Tannersville, 1906, *Rydberg 7957, 7954* (one sheet of this number Mr. Blanchard has determined as *R. hispidus*, the other as *R. setosus*. Both were from the same plant).

The following are intermediate or cannot be referred to either form:

VERMONT: North Windham, 1903, *Blanchard 251* (named *R. setosus*); Stratton, 1902, *Blanchard 199*.

NEW JERSEY: Musconetcong River, *Mackenzie 2108, 2300*.

NEW YORK: Tannersville, 1906, *Rydberg 7956*.

CONNECTICUT: Southington, 1904, *Andrews 60*.

Rubus hispidus × *vermontanus*. In my mind there is very little doubt but *R. jacens* Blanchard represents this hybrid. A

few specimens referred to *R. trifrons* by Blanchard apparently belong here also. The following specimens have been recorded:

VERMONT: Townsend, 1903, *Blanchard 241;* Stratton, 1904, *Blanchard 55, set 2*; South Londonderry, 1903, *Blahchard 250.*

NEW HAMPSHIRE: Alstead, 1903, *Blanchard 232, 231.*

Rubus cubitans Blanchard seems to me to be a mixture. The flowering branches and the new shoots were not collected at the same time. Do they belong to the same plant? The floral branches seem to me as typical *R. hispidus*, though with more flowers than usual. The leaflets of the new shoots have the texture of those of *R. hispidus* but the form of those of *R. vermontanus*. They may very well represent a hybrid.

Rubus argutus × *hispidus*. This was first recognized by Mr. Bicknell, who, however, did not characterize the same. Only Bicknell's specimens are known.

Rubus canadensis × *hispidus*. The only specimens seen, which may be referred to this hybrid, are the original ones cited in the North American Flora.

NOVA SCOTIA: Le Have River, *Macoun 81436a.*

NEW YORK BOTANICAL GARDEN

INDEX TO AMERICAN BOTANICAL LITERATURE

1912–1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Anastasia, G. E. Araldica nicotinae. Boll. Tecnico Coltiv. Tabac. **13**: 51–220. *pl. 1–82.* Au 1914. [Illust.]

An appendix to this number containing 60 plates additional, variously labeled A–Z, issued separately S 1914.

Appel, O. Disease resistance in plants. Science II. **41**: 773–782. 28 My 1915.

Appel, O. The relations between scientific botany and phytopathology. Ann. Missouri Bot. Gard. **2**: 275–285. 17 My 1915.

Atkinson, G. F. Phylogeny and relationships in the Ascomycetes. Ann. Missouri Bot. Gard. **2**: 315–376. *f. 1–10.* 17 My 1915.

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Belling, J. Inheritance of pod pubescence and partial sterility in *Stizolobium* crosses. Rep. Florida Agr. Exp. Sta. 1914: lxxxi-cv. *f. 1–9.* Ap 1915.

Benedict, R. C., *and others.* Where *Ophioglossum* grows (A multiple report). Am. Fern Jour. **5**: 42–50. My 1915.

Bessey, C. E. The phylogenetic taxonomy of flowering plants. Ann. Missouri Bot. Gard. **2**: 109–164. *f. 1.* 17 My 1915.

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Includes chapters by Crandall, Rigg, and Frye here indexed separately.

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STOUT: HIBISCUS OCULIROSEUS

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